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NATIONAL DAM INSPECTION PROGRAM. EDWARDS DAM (NDI ID NUMBER PA---ETC(U)
JUN 80 DACW31-80-C-0022

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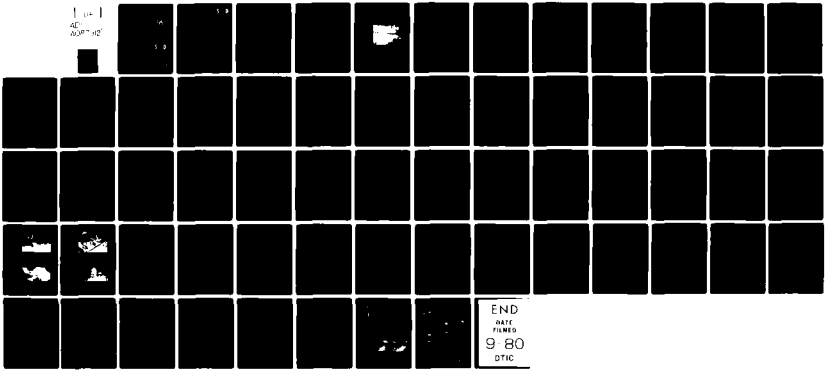

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OHIO RIVER BASIN
UNAMED TRIBUTARY OF TWO LICK CREEK, INDIANA COUNTY

PENNSYLVANIA

LEVEL II

AD A087912

EDWARDS DAM
NDI I.D. PA-00277
DER I.D. 32-36

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

D'APPOLONIA CONSULTING ENGINEERS
DACW31-80-C-0022

PREPARED FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
BALTIMORE, MARYLAND 21203

BY

D'APPOLONIA CONSULTING ENGINEERS
10 DUFF ROAD
PITTSBURGH, PA. 15235

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Edwards Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Indiana
STREAM: An Unnamed Tributary of Two Lick Creek
SIZE CLASSIFICATION: Small
HAZARD CLASSIFICATION: Significant
OWNER: Blair-Hirsch Interests
DATE OF INSPECTION: March 18, 1980 and March 19, 1980

ASSESSMENT: Based on the evaluation of the existing conditions, the condition of Edwards Dam is considered to be poor. The dam appears to have been abandoned and is no longer maintained. The crest and downstream face of the dam are covered with brush and trees up to 1-1/2 feet in diameter. The outlet facilities do not appear to be functional. The condition of the spillway structures was assessed to be fair.

According to the recommended criteria, small dams in the significant hazard category are required to pass from 100-year to 50 percent of the probable maximum flood (PMF). In view of the downstream damage potential, the upper limit of the recommended range is considered to be applicable to this dam. The flood discharge capacity was evaluated according to the recommended criteria and was found to pass 20 percent of the PMF without overtopping the low spot on the dam. Therefore, the flood discharge capacity of the spillway is classified to be inadequate.

The following recommendations should be implemented immediately or on a continuing basis.

1. The owner should immediately retain an experienced professional engineer to prepare and execute plans to provide adequate spillway capacity and restore the outlet facilities or to develop a procedure for orderly abandonment of the dam. Repair and restoration should include, but not be limited to, the following work:

   a. Conduct additional detailed hydrologic and hydraulic studies to more accurately ascertain the spillway capacity and the nature and extent of improvements required to provide adequate spillway capacity. In the interim, the

flashboard across the spillway should be removed, and the low spot on the crest of the dam should be filled.

b. Evaluate the operational condition of the outlet works facilities and develop a means for upstream control on all the pipes through the embankment.

c. Clear brush and trees on the embankment.

2. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

3. The dam and appurtenant structures should be inspected regularly and a formal maintenance manual should be developed for the future maintenance of the dam.

Lawrence D. Andersen, P.E.
Vice President

June 18, 1980
Date

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

17 JUN 1980
Date

EDWARDS DAM
NDI I.D. PA-277
DER I.D. 32-36
MARCH 18, 1980

Looking Downstream

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
EDWARDS DAM
(NDI I.D. PA-277,
DER I.D. 32-36)

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

a. Dam and Appurtenances. Edwards Dam consists of an earth embankment approximately 300 feet long with a maximum height of 30 feet from the downstream toe. The crest of the dam is irregular in the transverse direction with an average crest width of 8 feet. While the middle of the embankment is straight across the valley, short sections on each abutment side curve upstream. As designed, the embankment slopes are 2H to 1V on the upstream slope and 1.5H to 1V on the downstream slope.

The flood discharge facilities for the reservoir consist of a 15-foot-wide, 4-foot-deep open channel located on the left abutment, equipped with an ogee overflow section. Flow from the overflow section discharges onto a 10-foot-long concrete apron which in turn discharges into an earth channel.

The records indicate that the outlet facilities consist of a 12-inch cast-iron blow-off pipe and a 6-inch cast-iron supply line. Flow through the blow-off valve is controlled by a downstream valve located near the downstream toe of the embankment. The reservoir appears to be significantly silted. Therefore, the operational condition of the blow-off valve is questionable. This outlet system constitutes the emergency drawdown facility for the reservoir.

b. Location. Edwards Dam is located on an unnamed tributary of Two Lick Creek approximately one mile southeast of Coral in Center Township, Indiana County, Pennsylvania. Plate 1 illustrates the location of the dam.

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c. Size Classification. Small (based on 30-foot height and 17 acre-feet maximum storage capacity).

d. Hazard Classification. The dam is classified to be in the significant hazard category. Below the dam, the stream follows a narrow and steep valley flowing under a township road approximately 1500 feet downstream from the dam. Below this reach, the stream continues to flow west, flowing under Route 119 near Coral, Pennsylvania, approximately one mile downstream from the dam. Residential areas of the town of Coral are located in the vicinity of the Route 119 underpass. It is estimated that failure of the dam may cause shallow flooding, loss of a few lives, and property damage in the residential areas of Coral. It is estimated that the flooding in the vicinity of Coral is likely to be shallow.

e. Ownership. Blair-Hirsch Interests (address: Mr. D. Hall Blair, Agent and Partner, 143 North Sixth Street, Indiana, Pennsylvania 15701).

f. Purpose of Dam. The dam was built for industrial water supply. As reported by the owner, the water system associated with the reservoir has been eliminated and is no longer in use.

g. Design and Construction History. The dam was designed by C. W. Knight and Sons, engineers from Rome, New York, and built by the original owner, The Potter Coal and Coke Company, in 1917.

h. Normal Operating Procedure. As it presently exists, the reservoir is maintained at the top level of the flashboards across the spillway, which are approximately 0.6 foot above the crest of the ogee overflow section. When the lake is at or above the top of the flashboards, inflow is discharged through the uncontrolled spillway.

1.3 Pertinent Data. Elevations referred to in this and subsequent sections of the report were calculated based on field measurements assuming the spillway crest level (normal pool level) to be at Elevation 1180, USGS datum, as taken from the USGS 7-1/2-minute Bolivar quadrangle map (photorevised 1973). In the design drawings, the normal pool elevation is shown to be at Elevation 1194.2, which appears to be relative to a datum other than the current USGS datum.

a. Drainage Area — 0.37 square mile

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site	Unknown
Outlet conduit at maximum pool	10+
Gated spillway capacity at maximum pool	Not applicable

Ungated spillway capacity at maximum pool	201
Total spillway capacity at maximum pool	201

c. Elevation, USGS Datum (feet)

Top of Dam	1183.2 (measured low spot); 1184 (as designed)
Maximum pool	1183.2
Normal pool	1180.6 (top of flashboard)
Upstream invert outlet works	Unknown
Downstream invert outlet works	1154±
Maximum tailwater	Unknown
Toe of Dam	1154±

d. Reservoir Length (feet)

Normal pool level	300
Maximum pool level	350±

e. Storage (acre-feet)

Normal pool level	9.2
Maximum pool level	17±

f. Reservoir Surface (acres)

Normal pool level	1.8
Maximum pool level	2±

g. Dam

Type	Earth
Length	300 feet
Height	30 feet
Top width	8 feet
Side slopes	Downstream: 1.5H:1V Upstream: 2H:1V
Zoning	No
Impervious core	Yes
Cutoff	Yes
Grout Curtain	Yes

h. Regulating Outlet

Type	12-inch cast-iron pipe
Length	100± feet
Closure	Downstream valve
Access	At downstream toe of dam
Regulating facilities	Downstream valve

i. Spillway

Type	Ogee overflow section
Length	15 feet (perpendicular to flow)
Crest elevation	1180 (top of ogee; 1180.6 (top of flashboards)
Upstream channel	Lake
Downstream channel	Earth channel

SECTION 2
DESIGN DATA

2.1 Design

a. Data Available. The available data consist of files provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER), which contain design drawings, limited correspondence, and several past inspection reports.

(1) Hydrology and Hydraulics. The available information consists of spillway design drawings.

(2) Embankment. The available information includes a design drawing and a description of the embankment included in the past inspection reports.

(3) Appurtenant Structures. The available information consists of description of the appurtenant structures included in the previous inspection reports.

b. Design Features

(1) Embankment. As illustrated in Plate 2, the dam consists of a homogeneous embankment with a central concrete core wall. The longitudinal cross section of the embankment, included in Plate 3, indicates that the concrete core wall extended approximately 10 feet below the original ground surface and the foundation was grouted through the bottom of the cutoff trench. It is indicated that the foundation was grouted through holes drilled 4 feet on centers to a depth of 20 feet. The extent of grouting was not indicated. A Commonwealth report dated 1919 indicates that the embankment material consisted of shale, clay, sand and gravel available at the dam site. No reference was found relative to the manner in which the embankment was constructed.

(2) Appurtenant Structures. The plan and typical sections of the spillway structures are illustrated in Plate 3. The spillway structures consist of a 15-foot-wide concrete ogee overflow section discharging onto a 10-foot-long concrete apron. The concrete apron in turn discharges into an earth channel. As shown in Plate 2 and as observed in the field, the blow-off pipe consists of a 12-inch cast-iron pipe located left of the center of the embankment. However, in the previous dam inspection reports, references were found to two other cast-iron pipes through the embankment, which are likely to be the supply lines.

c. Design Data

(1) Hydrology and Hydraulics. No design data are available.

(2) Embankment. Other than the design drawings, no engineering data are available on the embankment.

(3) Appurtenant Structures. No design data are available on the appurtenant structures.

2.2 Construction. Available records indicate that the dam was constructed by the original owner, The Potter Coal and Coke Company. No information was found to indicate the manner in which the dam was constructed.

2.3 Operation. There are no formal operating records maintained for the dam.

2.4 Other Investigations. None reported.

2.5 Evaluation

a. Availability. The available information was provided by PennDER.

b. Adequacy

(1) Hydrology and Hydraulics. No design information is available to assess the adequacy of the spillway.

(2) Embankment. Available information is not considered to be sufficient to assess the structural adequacy of the embankment.

(3) Appurtenant Structures. Based on the review of the design drawings, the structural design of the spillway structures is considered to be adequate. No information is available on the design of the outlet facilities to assess their structural adequacy.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Edwards Dam consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.

2. Visual examination of the spillway structures.

3. Evaluation of downstream area hazard potential.

The specific observations are illustrated in Plate 4.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

In general, the condition of the embankment is considered to be poor. The dam is overgrown with trees up to 1-1/2 feet in diameter and appears to be no longer maintained. However, no signs of distress were noted that would affect the overall stability of the dam. Several wet areas were found below the toe of the dam. However, no seepage flow was found to be associated with these wet areas. The upstream face of the dam is irregular due to shoreline erosion and has no erosion protection. The crest of the dam is irregular in the transverse direction.

The crest of the dam was surveyed relative to the spillway crest elevation and it was found to be generally below the design crest elevation. The lowest point was found adjacent to the spillway approximately one foot below the design elevation. The downstream slope was surveyed and was found to be reasonably within the design slope of 1.5H to 1V.

c. Appurtenant Structures. The spillway structures were examined for deterioration and other signs of distress and obstructions that would limit flow. The spillway structures are considered to be in fair condition. As it presently exists, the overflow section is equipped with six-inch-high flashboards supported by a steel bar anchored at the center of the ogee overflow section. This condition is considered to pose a potential for blockage of the spillway by debris during major floods. Removal of the flashboards and flashboard bar is recommended.

As to the outlet works, only the downstream end of the outlet pipe and the stem of the blow-off pipe were visible. The operational condition of the blow-off valve was not observed.

d. Reservoir Area. A map review and visual observations indicate that the watershed is predominantly covered by woodlands. No signs of landslide activity in the vicinity of the reservoir were found. A review of the regional geology is included in Appendix F.

e. Downstream Channel. Below the dam, the stream initially flows under a township road approximately 1500 feet downstream from the dam and then continues to flow westward under U.S. Route 119 approximately one mile downstream from the dam near the town of Coral. A further description of the downstream conditions is included in Section 1.2d.

3.2 Evaluation. The overall condition of the dam is considered to be poor. The dam has been overgrown with trees up to 1-1/2 feet in diameter and is no longer being maintained.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the dam. As it presently exists, the reservoir is normally maintained at the crest level of the flashboards across the uncontrolled spillway.

4.2 Maintenance of the Dam. The visual observations indicate that the dam has essentially been abandoned. Maintenance is nonexistant.

4.3 Maintenance of Operating Facilities. It appears that the operating facilities, which consist of a blow-off pipe valve located at the downstream toe, are also not being maintained. The operational condition of the blow-off pipe valve was not observed.

4.4 Warning System. No formal warning system exists for the dam. Telephone communication facilities are available via residences in the vicinity of the dam.

4.5 Evaluation. The visual observations indicate that the dam is essentially abandoned and is no longer maintained. As mentioned previously, it is considered advisable that either the dam be adequately maintained or procedures developed for its orderly abandonment.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Edwards Dam has a watershed of 0.37 square mile and impounds a reservoir with a surface area of 1.8 acres at normal pool level. The flood discharge facilities consist of an open channel spillway located near the left abutment. The spillway is approximately 15 feet wide and 4 feet deep. On the dates of inspection, the spillway was equipped with flashboards reducing the available freeboard to 3.2 feet. The capacity of the spillway, based on the available 2.6 feet of freeboard from the top of the flashboards to the low spot on the crest of the dam, was determined to be 201 cfs, as indicated in the computer output in Appendix D.

b. Experience Data. As previously stated, Edwards Dam is classified as a small dam in the significant hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass from the 100-year flood to one-half PMF. In view of the downstream hazard potential, the upper limit of the recommended range is considered to be applicable to this dam.

The PMF inflow hydrograph for the reservoir was determined utilizing the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Engineering Center of the U.S. Army, Corps of Engineers. The data used for the computer analysis are presented in Appendix D. The one-half PMF inflow hydrograph was found to have a peak flow of 510 cfs. The 100-year flood, calculated according to the recommended procedure, was found to have a peak flow of 580 cfs, which is in excess of the computed one-half PMF peak flow. It appears that due to the small watershed, the procedure used for calculating the PMF yields a low estimate for the peak discharge, causing the computed 100-year flood to be in excess of 50 percent of the computed PMF. Computer input and summary of computer output for the PMF analysis and the 100-year flood calculations are included in Appendix D.

c. Visual Observations. Although the presence of flashboards across the overflow section of the spillway is considered to pose a potential for blockage of the spillway by debris during major storms which would reduce the spillway discharge capacity, no reduction in the capacity due to blockage by debris was considered for the purpose of evaluating the adequacy of the spillway.

d. Overtopping Potential. Various percentages of the PMF inflow hydrograph were routed through the reservoir, and it was

found that the spillway can pass 20 percent of the PMF without overtopping the embankment, assuming the flashboards do not fail. It was found that during the passage of 50 percent PMF, the dam would be overtopped for a duration of 3.5 hours with a maximum depth of 0.9 foot over the low spot on the crest of the dam. A further analysis indicates that if the flashboards across the spillway were to be removed and the low spot on the crest were to be filled to design crest elevation, the spillway would pass 40 percent of the PMF without overtopping the embankment; and at 50 percent of the PMF, the dam crest would be overtopped for a duration of 2.0 hours with a maximum depth of 0.2 foot.

e. Spillway Adequacy. The spillway was found to pass 20 percent of the PMF without overtopping the embankment, which is less than the required spillway capacity of 50 percent of the PMF. Therefore, the spillway capacity is classified to be inadequate.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, although the overall condition of the embankment was considered to be poor, no conditions were observed which were considered serious relative to the overall stability of the dam at this time.

(2) Appurtenant Structures. The spillway structures were found to be structurally in fair condition. Only the downstream end of the blow-off valve was visible. Therefore, the structural adequacy of the outlet facilities could not be assessed.

b. Design and Construction Data

(1) Embankment. The available information does not include any data to aid in the assessment of the structural stability of the dam. Review of the available data indicates that the design incorporated a concrete cutoff and core wall and foundation grouting for seepage control through the embankment. As previously noted, the deficiencies observed in the embankment during this inspection were not considered to be serious relative to the overall stability of the dam at this time. Therefore, based on visual observations, the static stability of the dam is considered to be adequate.

(2) Appurtenant Structures. Based on visual observations, the spillway structures were found to structurally adequate. The structural condition of the outlet facilities could not be assessed.

c. Operating Records. The structural stability of the dam is not considered to be affected by the operational features of the dam.

d. Post-Construction Changes. None reported.

e. Seismic Stability. The dam is located in Seismic Zone 1, and based on visual observations, the static stability of the dam appears to be adequate. Therefore, based on the recommended criteria for the evaluation of seismic stability of dams, the structure is presumed to present no hazard as a result of earthquakes.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. The visual observations indicate that Edwards Dam is in poor condition. The dam appears to have been abandoned and is no longer being maintained. The dam is overgrown with trees up to 1-1/2 feet in diameter. The dam crest is irregular in both transverse and longitudinal directions. The reservoir drawdown facilities do not appear to be functional at this time.

In view of the above conditions, it is recommended that the overall condition of the dam be evaluated by an experienced professional engineer to prepare plans to restore the embankment and develop procedures for its continued maintenance or to develop a procedure for orderly abandonment of the dam.

The spillway capacity of 20 percent of the PMF was found to be less than the recommended spillway capacity of 50 percent of the PMF. Therefore, the spillway is classified as inadequate.

b. Adequacy of Information. Available information, in conjunction with visual observations and the previous experience of the inspectors, is considered to be sufficient to make the following recommendations.

c. Urgency. The following recommendations should be implemented immediately or on a continuing basis.

d. Necessity for Additional Data. In view of the conditions described above, the owner should retain an experienced professional engineer to prepare and implement plans for restoration of the dam or to develop a procedure for orderly abandonment of the dam.

7.2 Recommendations/Remedial Measures. It is recommended that the following recommendations be implemented immediately or on a continuing basis:

1. The owner should immediately retain an experienced professional engineer to prepare and execute plans to provide adequate spillway capacity and restore the outlet facilities or to develop a procedure for orderly abandonment of the dam. Repair and restoration should include, but not be limited to, the following work:

a. Conduct additional detailed hydrologic and hydraulic studies to more accurately ascertain the spillway capacity and the nature and extent of improvements required to provide adequate spillway capacity. In the interim, the flashboard across the spillway should be removed, and the low spot on the crest of the dam should be filled.

b. Evaluate the operational condition of the outlet works facilities and develop a means for upstream control on all the pipes through the embankment.

c. Clear brush and trees on the embankment.

2. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

3. The dam and appurtenant structures should be inspected regularly and a formal maintenance manual should be developed for the future maintenance of the dam.

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Edwards Dam COUNTY Indiana STATE Pennsylvania ID# NDI I.D. PA-277 DER I.D. 32-36

TYPE OF DAM Earth HAZARD CATEGORY Significant

DATE(S) INSPECTION March 18, 1980 WEATHER Cloudy TEMPERATURE 30s

POOL ELEVATION AT TIME OF INSPECTION 1180.6 M.S.L. TAILWATER AT TIME OF INSPECTION 1154± M.S.L.

INSPECTION PERSONNEL:

B. Erel

W. T. Chan

REVIEW INSPECTION PERSONNEL:
(March 19, 1980)

E. D'Appolonia

L. D. Andersen

J. H. Poellot

B. Erel

OWNER'S REPRESENTATIVE:

None

B. Erel RECORDER

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The dam crest is irregular in the transverse direction. See Plate 5 for the longitudinal dam crest profile.	
RIPRAP FAILURES	The upstream slope has no erosion protection.	The upstream slope of the dam should be provided with adequate erosion protection.

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No signs of distress.	
ANY NOTICEABLE SEEPAGE	There are several wet areas below the toe of the dam. However, no seepage appears to be associated with these wet areas.	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Outlet pipe is a 12-inch cast-iron pipe. Only the downstream end was visible.	
INTAKE STRUCTURE	Submerged	
OUTLET STRUCTURE	The outlet pipe has no outlet structure.	
OUTLET CHANNEL	None	
EMERGENCY GATE	Flow through the outlet pipe is controlled by a valve located at the downstream toe. Only the stem of the valve was visible.	The operational condition of the blow-off valve should be evaluated and necessary maintenance performed.

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	In fair condition. The spillway is equipped with a 6-inch-high flashboard.	The flashboard and the bar supporting the flashboard located at the center of the overflow section should be removed.
APPROACH CHANNEL	Lake	
DISCHARGE CHANNEL	A concrete apron, in fair condition, and earth discharge channel.	
BRIDGE AND PIERS	None	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable	
APPROACH CHANNEL	Not applicable	
DISCHARGE CHANNEL	Not applicable	
BRIDGE PIERS	Not applicable	
GATES AND OPERATION EQUIPMENT	Not applicable	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderately steep to steep. No significant shoreline erosion or indications of landslides.	
SEDIMENTATION	The reservoir appears to be significantly filtered.	
UPSTREAM RESERVOIRS	None	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Sediment eroding from the spillway discharge channel is being placed across the valley approximately 500 feet downstream from the dam, obstructing drainage from the toe area of the embankment.	This debris should be removed to provide adequate drainage to the toe area of the dam.
SLOPES	No features pertinent to the safety of the dam.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Approximately three to six houses are located about one mile downstream from the dam which are likely to be in the potential flood plain. Population: approximately 10 to 20.	

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
AND HYDROLOGIC AND HYDRAULIC
PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Edwards Dam
ID# NDI I.D. PA-277
DER I.D. 32-36

ITEM	REMARKS
AS-BUILT DRAWINGS	Available in Commonwealth files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was designed by C. W. Knight and Sons, engineers from Rome, New York in 1917. The dam was constructed by the original owner, The Potter Coal and Coke Company, with completion in 1917.
TYPICAL SECTIONS OF DAM	See Plate 2.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	None available

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not maintained
DESIGN REPORTS	None prepared
GEOLOGY REPORTS	None prepared
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None reported

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported
BORROW SOURCES	Unknown
MONITORING SYSTEMS	None
MODIFICATIONS	None reported
HIGH POOL RECORDS	Not recorded

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None reported
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported
MAINTENANCE OPERATION RECORDS	Not maintained
SPILLWAY PLAN SECTIONS DETAILS	See Plate 3.
OPERATING EQUIPMENT PLANS AND DETAILS	None available

CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 0.37 square mile (woodlands)

ELEVATION, TOP OF NORMAL POOL AND STORAGE CAPACITY: 1180 (9.2 acre-feet)

ELEVATION, TOP OF FLOOD CONTROL POOL AND STORAGE CAPACITY: 1183.2 (17 acre-feet)

ELEVATION, MAXIMUM DESIGN POOL: 1183.2

ELEVATION, TOP OF DAM: 1183.2 (measured low spot); 1184 (as designed)

SPILLWAY:

a. Elevation 1180 (top of concrete overflow section)

b. Type Ogee overflow section

c. Width 15 feet (perpendicular to flow)

d. Length Not applicable

e. Location Spillover Adjacent to spillway

f. Number and Type of Gates None

OUTLET WORKS:

a. Type 12-inch cast-iron blow-off pipe

b. Location Left of center

c. Entrance Inverts Unknown

d. Exit Inverts 1184±

e. Emergency Drawdown Facilities 12-inch blow-off pipe

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location None

c. Records None

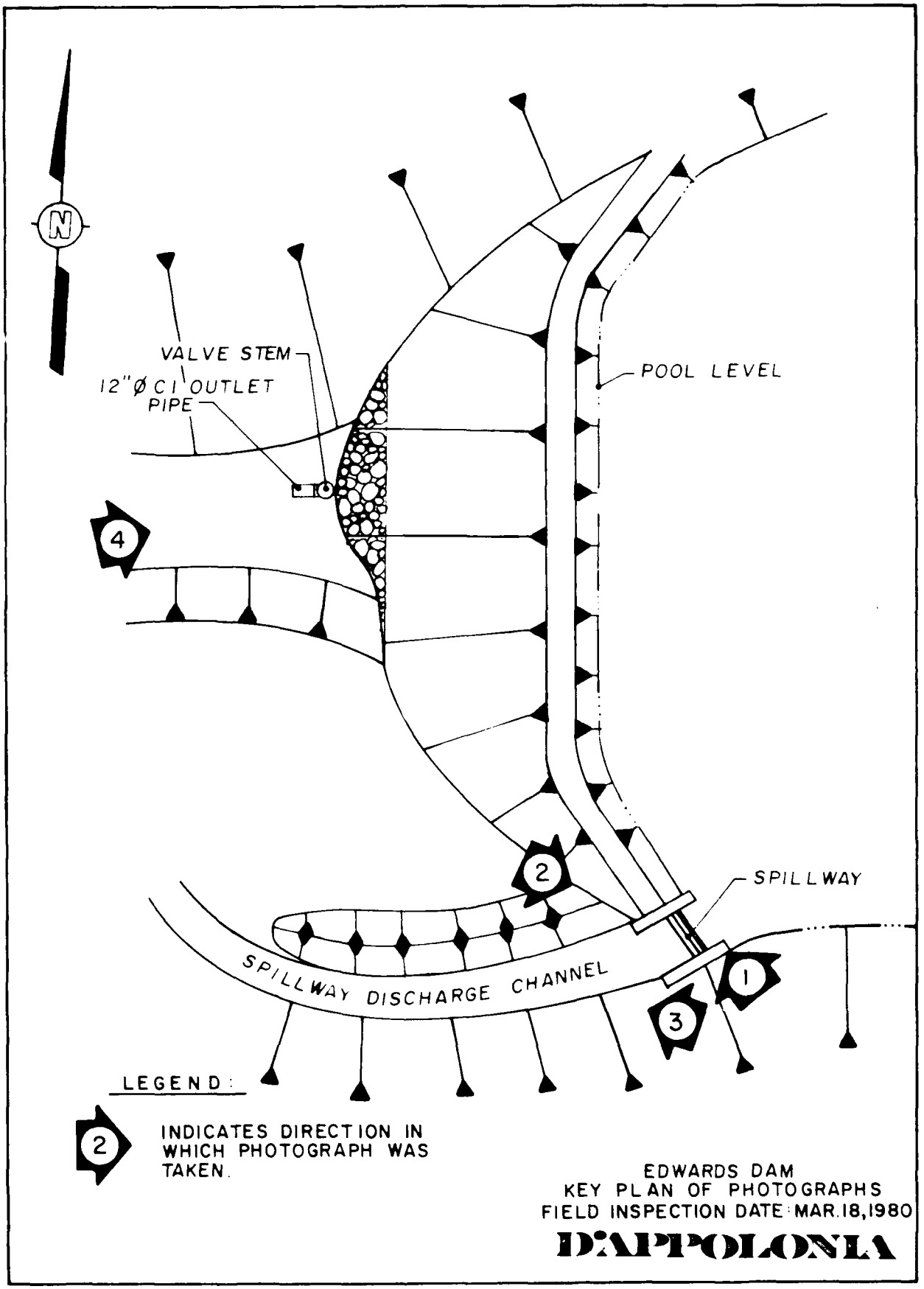
MAXIMUM NONDAMAGING DISCHARGE: 200± cfs (existing spillway capacity)

APPENDIX C

PHOTOGRAPHS

LIST OF PHOTOGRAPHS
EDWARDS DAM
NDI I.D. PA-277
DER I.D. 32-36
MARCH 18, 1980

PHOTOGRAPH NO.	DESCRIPTION
1	Crest (looking north).
2	Spillway (note flashboards).
3	Spillway discharge channel (looking downstream).
4	Outlet pipe (downstream end).



EDWARDS DAM
KEY PLAN OF PHOTOGRAPHS
FIELD INSPECTION DATE: MAR. 18, 1980

DAPPOLONIA

Photograph No. 1
Crest (looking north).

Photograph No. 2
[illegible] (note flashboards).

Photograph No. 3

Spillway discharge channel (looking downstream).

Photograph No. 4

Outlet pipe (downstream end).

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Edwards Dam (NDI I.D. PA-277)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.8 INCHES/24 HOURS[1]

STATION	1	2	3	4	5
Station Description	Lake	Dam			
Drainage Area (square miles)	0.37	-			
Cumulative Drainage Area (square miles)	0.37	0.37			
Adjustment of PMF for Drainage Area (%)[2]	(ZONE 7)				
6 Hours	102	-			
12 Hours	120	-			
24 Hours	130	-			
48 Hours	140	-			
72 Hours	-	-			
Snyder Hydrograph Parameters					
Zone[3]	24	-			
C_p/C_t[4]	0.45/1.6	-			
L (miles)[5]	0.8	-			
L_{ca} (miles)[5]	0.4	-			
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	1.1	-			
Spillway Data					
Crest Length (ft)	-	15			
Freeboard (ft)	-	2.6[6]			
Discharge Coefficient	-	3.2[7]			
Exponent	-	1.5			

[1] Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.

[2] Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.

[3] Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).

[4] Snyder's Coefficients.

[5] L = Length of longest water course from outlet to basin divide.
L_{ca} = Length of water course from outlet to point opposite the centroid of drainage area.

[6] 3.2 feet of freeboard if existing flashboard removed.

[7] Assumed based on field observation.

STORAGE VS. ELEVATION

ELEVATION	ΔH, FEET	AREA (ACRES)[1]	ΔVOLUME (ACRE-FEET)[2]	STORAGE (ACRE-FEET)
1180[3]	20	1.8	45.6	0
1200		2.8		45.6

[1] Planimetered from USGS maps.

[2] $\Delta Volume = \Delta H/3 \ (A_1 + A_2 + \sqrt{A_1 A_2})$.

[3] Normal pool elevation (without flashboards).

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                A1       SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND DAM OVERTOPPING ANALYSES
    2                A2       EDWARDS DAM, INDIANA COUNTY, NDI-I D PA 277            PROJECT NO. 79-543-14
    3                A3       FOR 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, AND 50% PMF
    4                B    300        0       10        0        0        0        0        0       -4        0
    5                B1     5
    6                J      1        9        1
    7                J1  0.05     0.10     0.15     0.20     0.25     0.30     0.35     0.40     0.50
    8                K      0        1                                             1
    9                K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO EDWARDS DAM
   10                M      1        1     0.37             0.37                                    1
   11                P              23.8      102      120      130      140
   12                T                                                      1.0      .05             0.0077
   13                W   1.09     0.45
   14                X   -1.0    -0.05      2.0
   15                K      1        2                                             1
   16                K1       ROUTING FLOW THROUGH EDWARDS DAM (NDI-I. D. PA. 277)WITH 0.6' FLUSH BOARD
   17                Y                                        1        1
   18                Y1     1                                                -1180.6
   19                $A   1.8      2.8
   20                $E1180.0   1200.0
   21                $$1180.6     15.0      3.2      1.5
   22                $D1183.2     3.08      1.5    280.0
   23                $L  25.0     65.0     80.0    180.0    230.0    280.0
   24                $V1183.2   1183.5   1183.6   1184.2   1184.3   1184.4
   25                K     99
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .05	RATIO 2 .10	RATIO 3 .15	RATIO 4 .20	RATIO 5 .25	RATIO 6 .30	RATIO 7 .35	RATIO 8 .40	RATIO 9 .50
HYDROGRAPH AT	1	.37	1	51.	102.	153.	204.	255.	306.	357.	408.	510.
	(	.96)	(	1.45)(	2.89)(	4.34)(	5.78)(	7.23)(	8.67)(	10.12)(	11.56)(	14.45)
ROUTED TO	2	.37	1	48.	98.	148.	198.	249.	300.	350.	407.	508.
	(	.96)	(	1.37)(	2.78)(	4.20)(	5.62)(	7.05)(	8.48)(	9.92)(	11.53)(	14.38)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1180.60	1180.60	1183.20
STORAGE	1.	1.	6.
OUTFLOW	0.	0.	201.

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	1181.60	0.00	3.	48.	0.00	41.00	0.00
.10	1182.21	0.00	4.	98.	0.00	41.00	0.00
.15	1182.72	0.00	5.	148.	0.00	41.00	0.00
.20	1183.17	0.00	6.	198.	0.00	41.00	0.00
.25	1183.48	.28	7.	253.	1.83	40.83	0.00
.30	1183.66	.46	7.	304.	2.67	40.83	0.00
.35	1183.79	.59	7.	355.	3.17	40.83	0.00
.40	1183.91	.71	7.	406.	3.83	40.67	0.00
.50	1184.09	.89	8.	509.	4.83	40.67	0.00

OVERTOPPING ANALYSIS SUMMARY

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                A1       SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND DAM OVERTOPPING ANALYSES
    2                A2       EDWARDS DAM, INDIANA COUNTY, NDI-I.D.PA.277              PROJECT NO.79-543-14
    3                A3       FOR 5%,10%,15%,20%,25%,30%,35%,40%, AND 50% PMF
    4                B    300        0       10        0        0        0        0        0       -4        0
    5                B1     5
    6                J      1        9        1
    7                J1  0.05     0.10     0.15     0.20     0.25     0.30     0.35     0.40     0.50
    8                K      0        1                                             1
    9                K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO EDWARDS DAM
   10                M      1        1     0.37              0.37                                    1
   11                P              23.8      102      120      130      140
   12                T                                                          1.0       05              0.0077
   13                W   1.09     0.45
   14                X   -1.0    -0.05      2.0
   15                K      1        2                                             1
   16                K1       ROUTING FLOW THROUGH EDWARDS DAM (NDI-I.D.PA.277)DESIGN CREST ELEVATION
   17                Y                                         1        1
   18                Y1     1                                                 -1180.0
   19                $A   1.8      2.8
   20                $E1180.0   1200.0
   21                $$1180.0     15.0      3.2      1.5
   22                $D1184.0     3.08      1.5    280.0
   23                K     99
```

COMPUTER INPUT OVERTOPPING ANALYSIS
(USING DESIGN CREST ELEVATION)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1180.00	1180.00	1184.00
STORAGE	0.	0	8.
OUTFLOW	0.	0.	384.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	1181.00	0.00	2.	48.	0.00	41.00	0.00
.10	1181.61	0.00	3.	98.	0.00	41.00	0.00
.15	1182.12	0.00	4.	148.	0.00	41.00	0.00
.20	1182.58	0.00	5.	198.	0.00	41.00	0.00
.25	1183.00	0.00	6.	249.	0.00	40.83	0.00
.30	1183.39	0.00	6.	300.	0.00	40.83	0.00
.35	1183.76	0.00	7.	350.	0.00	40.83	0.00
.40	1184.06	.06	8.	407.	.67	40.83	0.00
.50	1184.22	.22	8.	508.	2.00	40.67	0.00

OVERTOPPING ANALYSIS SUMMARY
(USING DESIGN CREST ELEVATION)

D'APPOLONIA
CONSULTING ENGINEERS, INC

By WTC Date 5/23/80 Subject EDWARDS DAM Sheet No. 1 of 1
Chkd. By BE Date 5/28/80 NDI-I.D. PA 277 — 100 YR FLOOD Proj. No. 79-543-14

100 YEAR FLOOD PEAK INFLOW USING COE REGRESSION ANALYSIS

$$Q_{100}\ (cfs) = 120.38\ (D.A. \times S^{1/2})^{0.744}$$

Where D.A = WATERSHED AREA, = 0.37 SQ MILE
S = Slope of FIRST (0.7 x Length) REACH IN FT/MILE

LONGEST WATER COURSE = 0.8 MILES

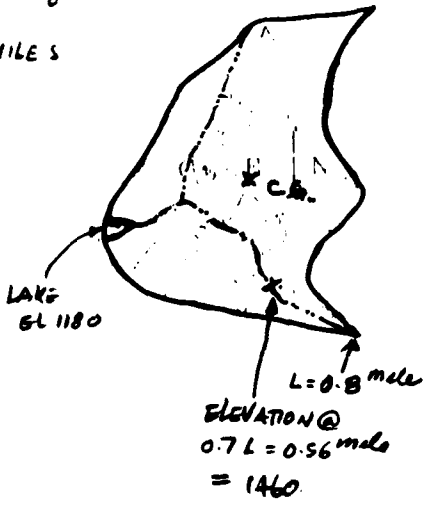
0.7 x 0.8 = 0.56 MILE

ELEVATION @ 0.56 mile = 1460

$$\text{SLOPE, } S = \frac{1460-1180}{0.56}$$

$$= \frac{280}{0.56}$$

$$= 500\ FT/MILE$$



$$Q_{100} = 120.38\ (0.37\sqrt{500})^{0.744}$$

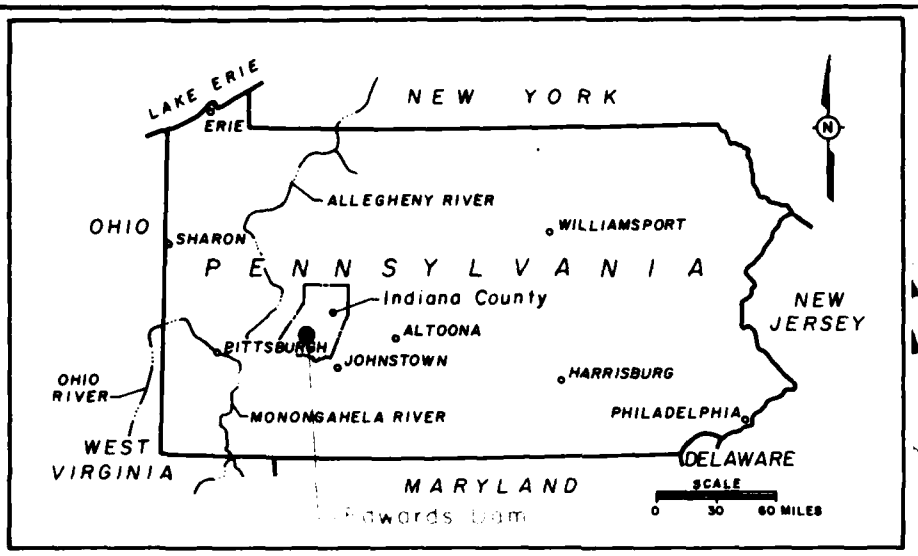
$$= 580\ cfs$$

> 510 cfs = 50% PMF PER HEC. 1.

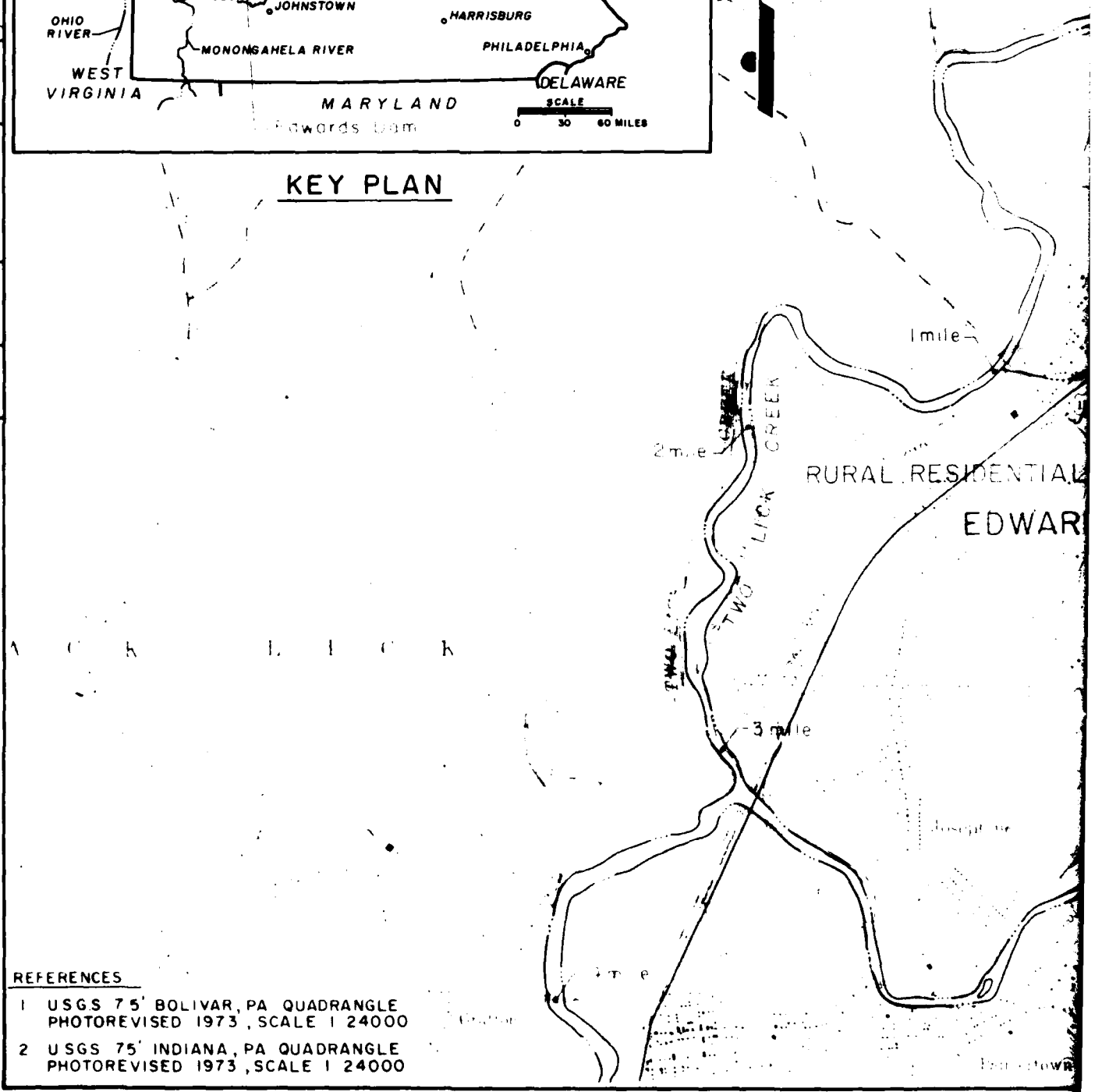
APPENDIX E

PLATES

DRAWN BY	CHECKED BY	DRAWING NUMBER
ACS		79-543-B64
11-7-79	APPROVED BY	



KEY PLAN



REFERENCES

1 USGS 7.5' BOLIVAR, PA QUADRANGLE PHOTOREVISED 1973, SCALE 1 24000

2 USGS 7.5' INDIANA, PA QUADRANGLE PHOTOREVISED 1973, SCALE 1 24000

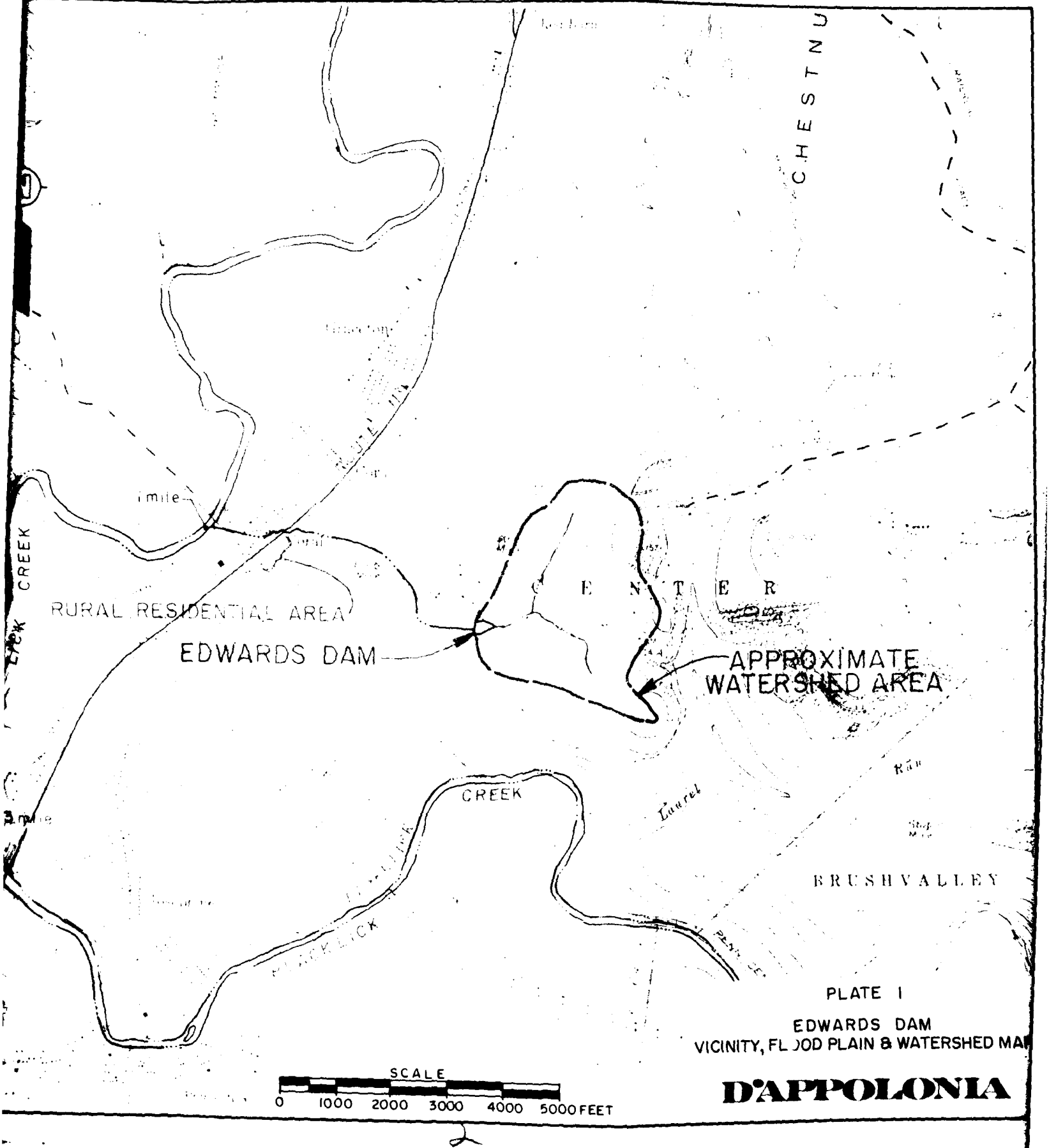
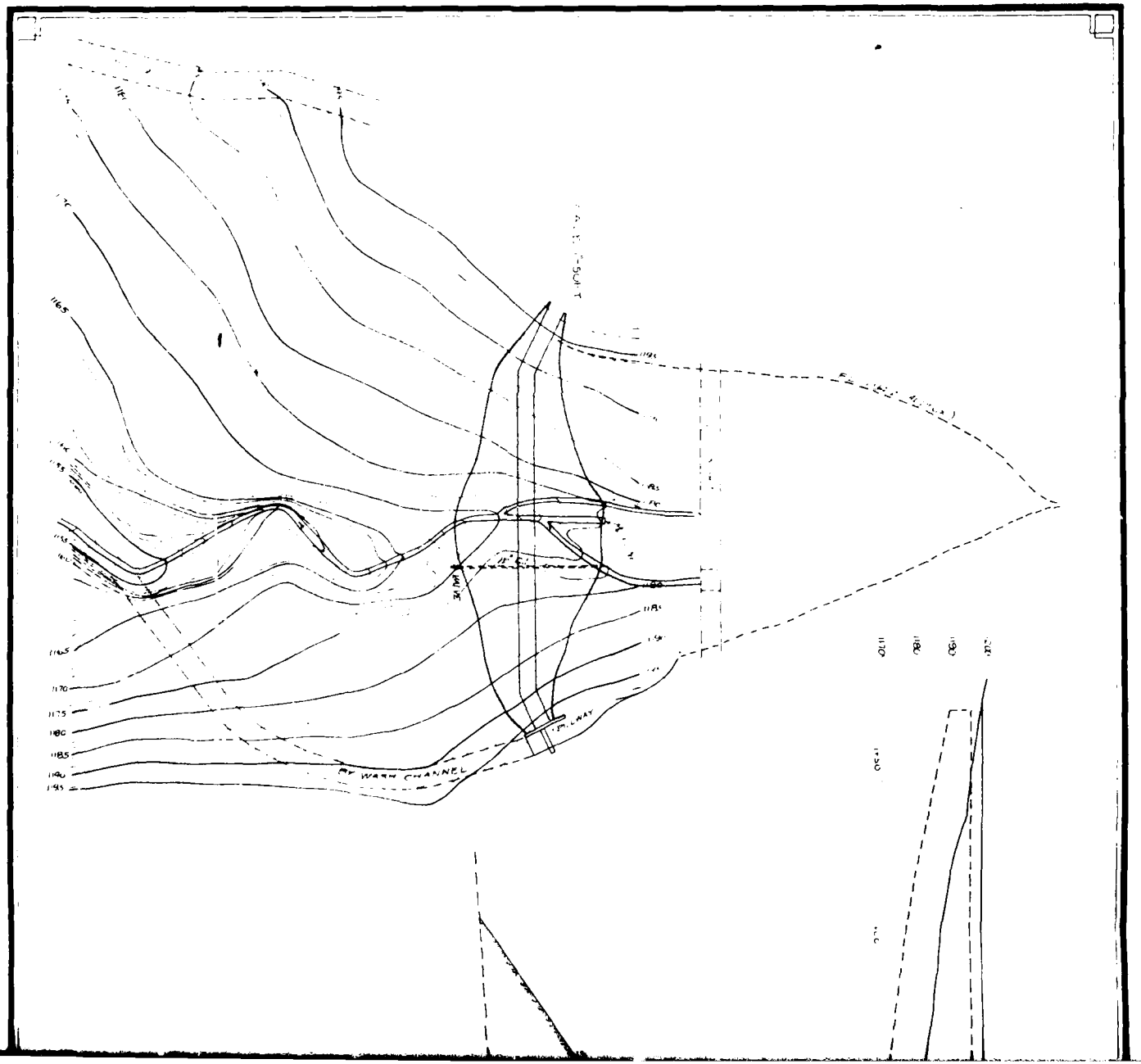


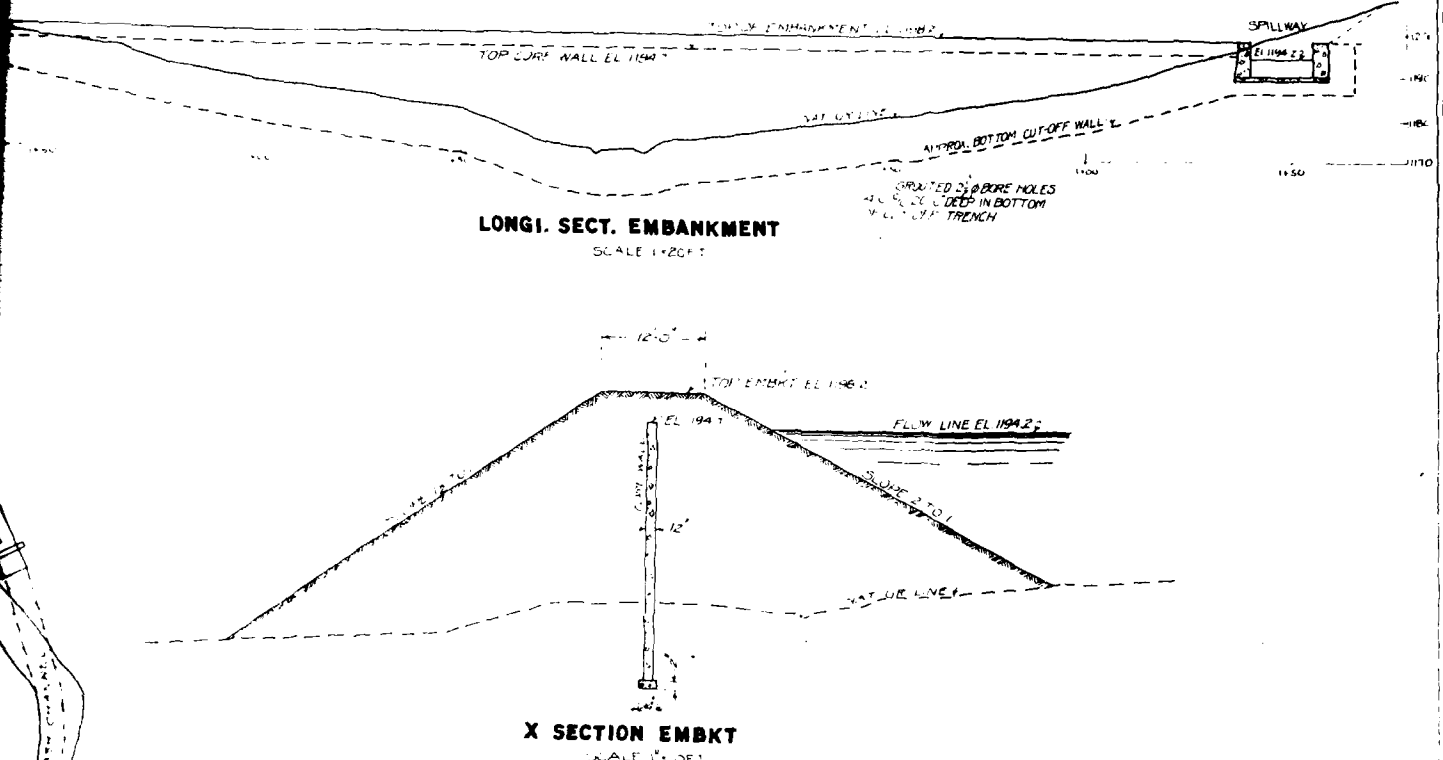
PLATE 1

EDWARDS DAM
VICINITY, FLOOD PLAIN & WATERSHED MAP

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BC		DRAWING NUMBER 79-543-B65
	5-27 80	APPROVED BY	JH	5-30-80	





LONGI. SECT. EMBANKMENT

SCALE 1"=20FT

X SECTION EMBKT

SCALE 1"=10FT

UPPER RESERVOIR

POTTER COAL & COKE CO.

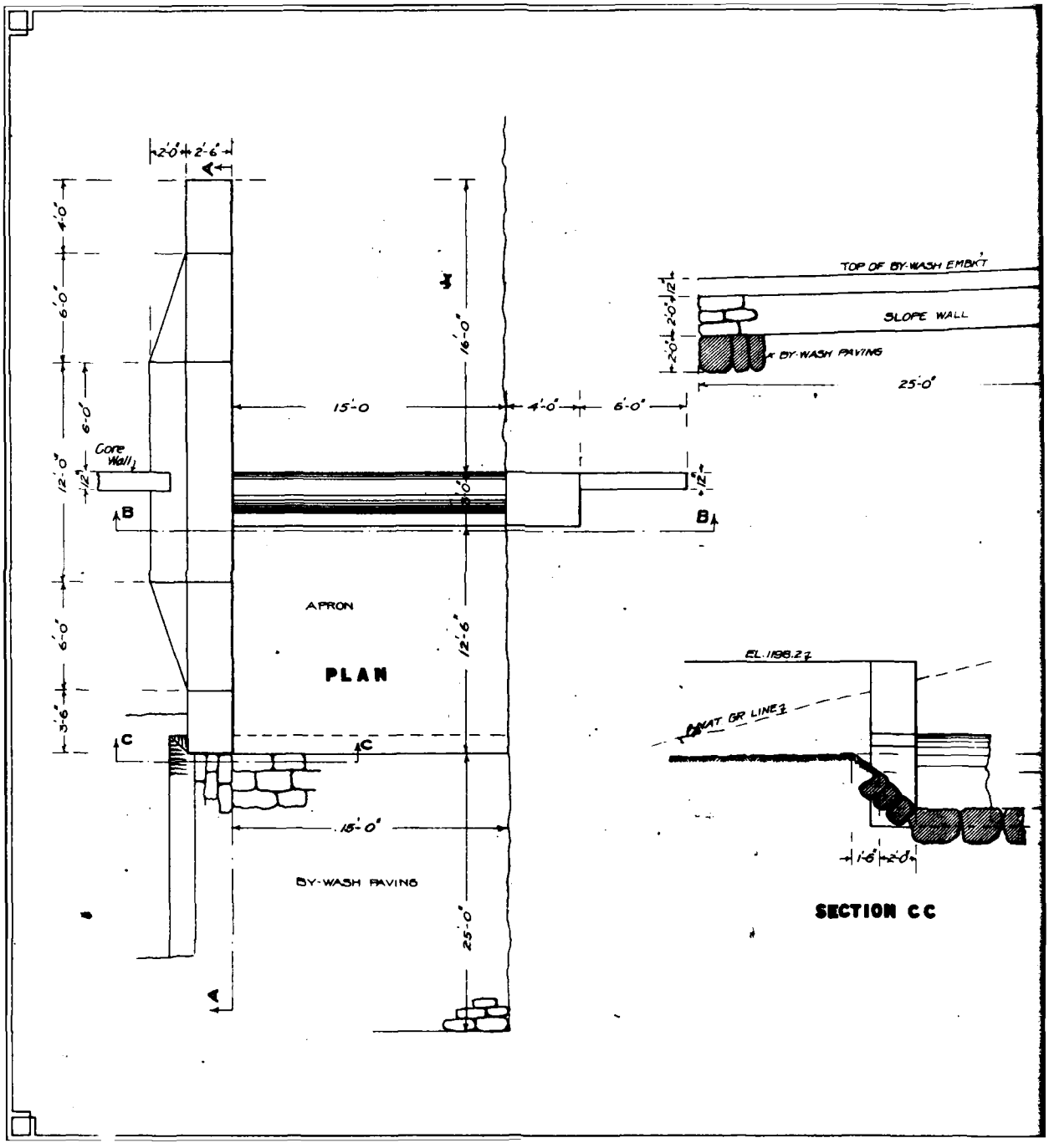
CORAL PENN.

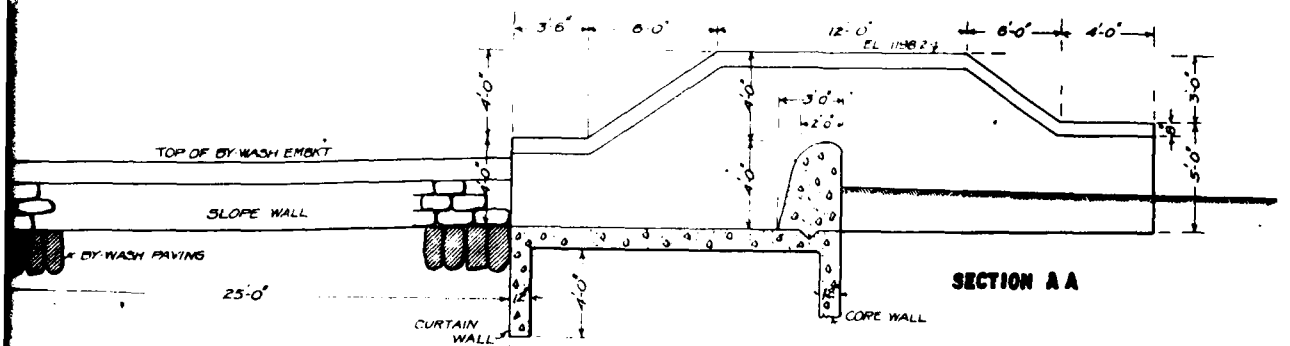
MAR 1917

PLATE 2

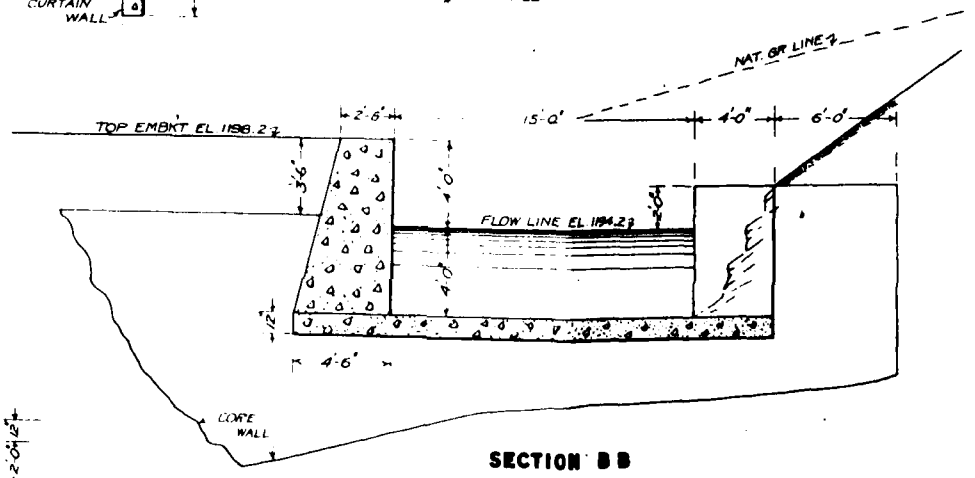
2

D'APPOLONIA

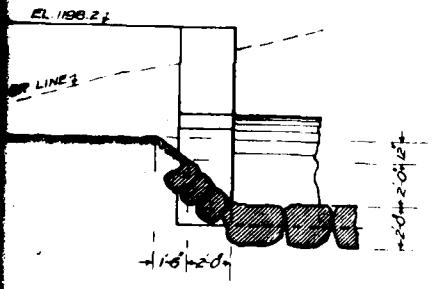

2'-0"
2'-6"
4'-0"
6'-0"
6'-0"
12'-0"
1'-2"
Core Wall
B
B
15'-0
4'-0"
6'-0"
16'-0"
1'-0"
1'-2"
APRON
PLAN
6'-0"
3'-6"
C
C
12'-6"
15'-0"
BY-WASH PAVING
25'-0"
TOP OF BY-WASH EMBKT
SLOPE WALL
BY-WASH PAVING
2'-0"
1'-2"
25'-0"
EL. 198.27
NAT. GR. LINE
1'-6"
2'-0"
SECTION C C



SECTION A A



SECTION B B



SECTION C C

SCALE 1/4" = 1'-0"

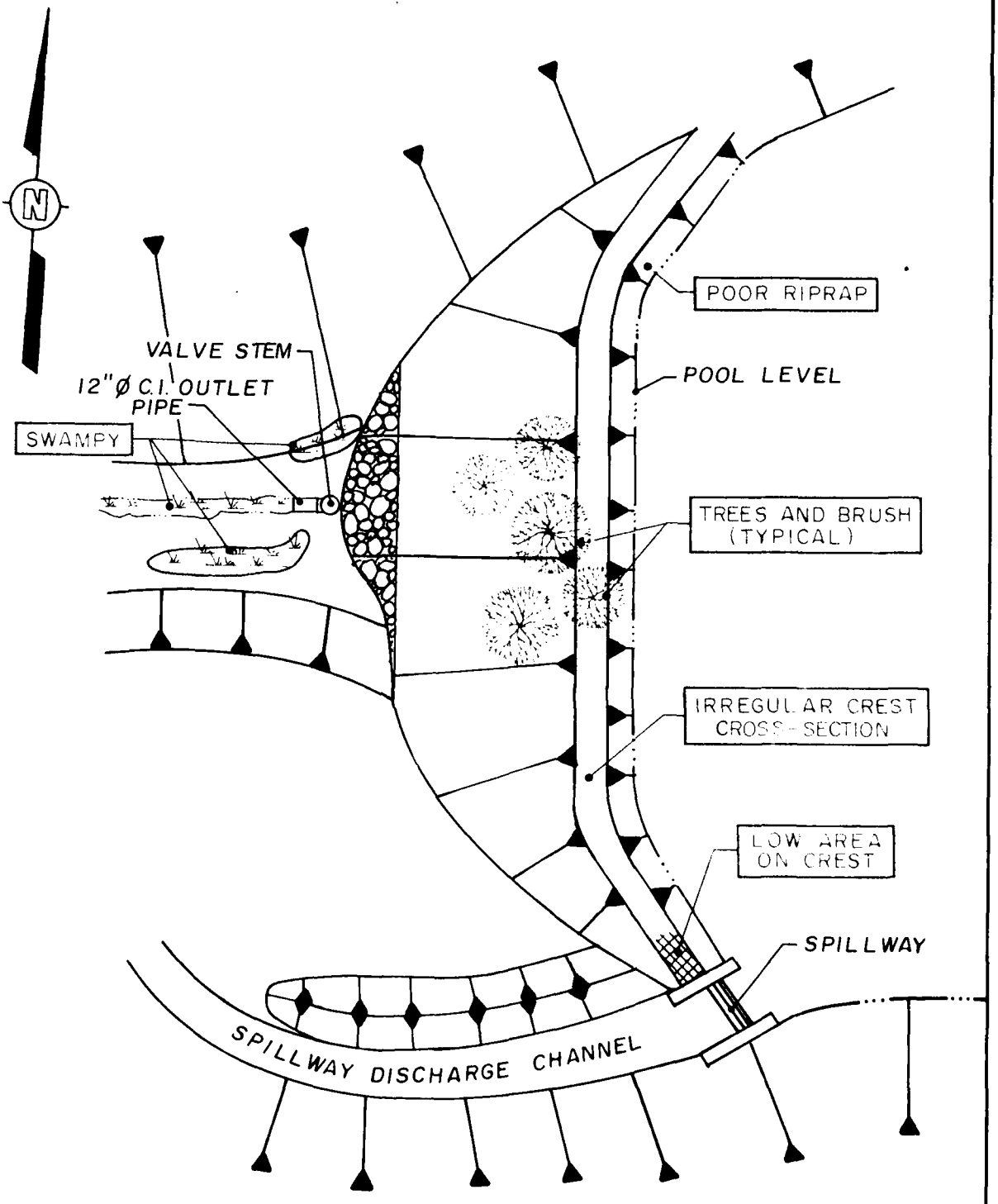
SPILLWAY UPPER RESERVOIR

POTTER COAL & COKE CO.
CORAL PENN.
MAR 1957

C.W. Knight & Son Engrs. Rome N.Y. Dwg No. 3710

PLATE 3

DRAWN BY	CHECKED BY	DRAWING NUMBER
ACS		79-043-A39
5-20-80	APPROVED BY	



NOTES:

1. POOL LEVEL DATE OF INSPECTION: 1.0 FT. ABOVE SPILLWAY CREST

PLATE 4

EDWARDS DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE: MAR. 18, 1980

D'APPOLONIA

APPENDIX F

REGIONAL GEOLOGY

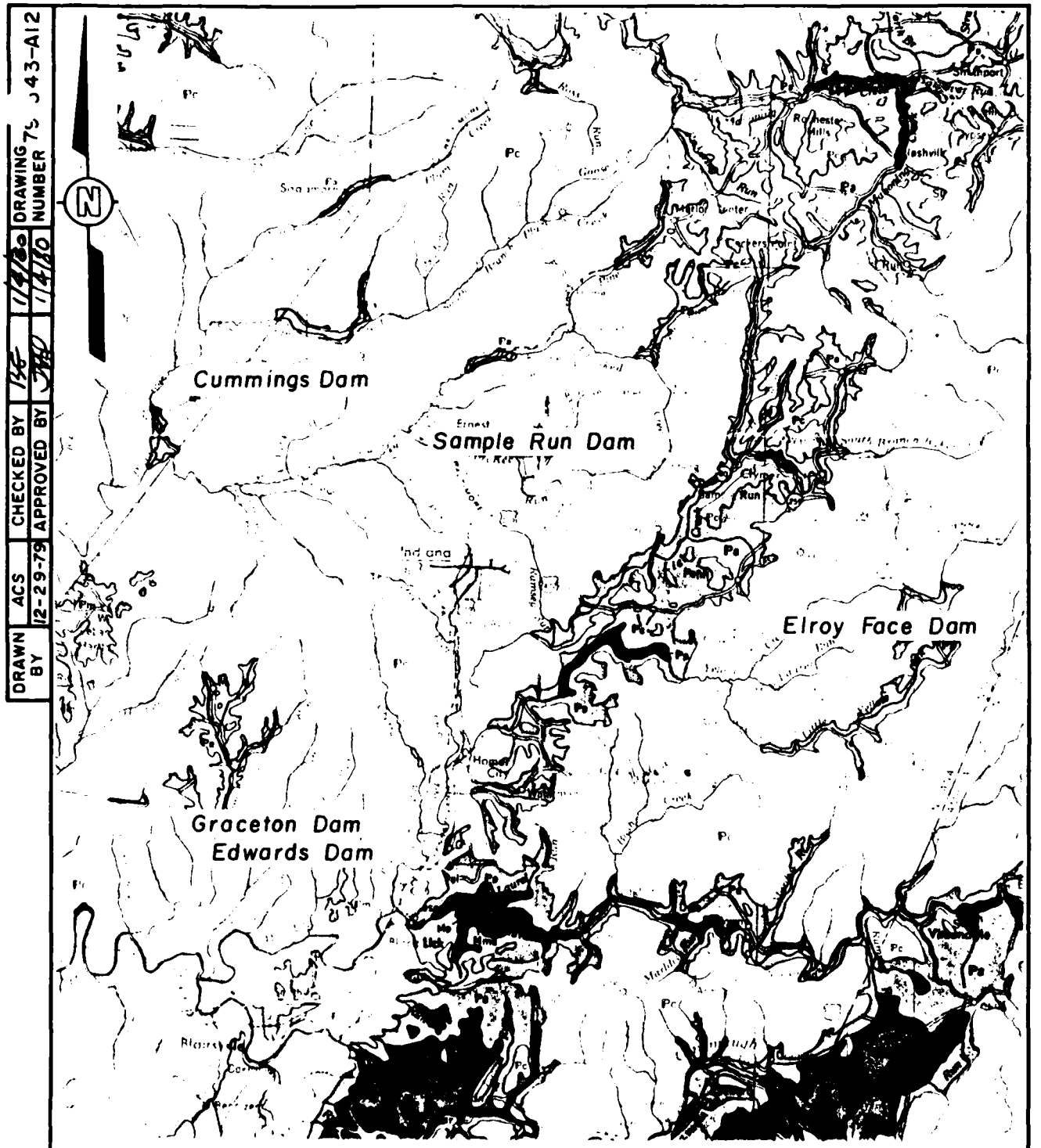
APPENDIX F

REGIONAL GEOLOGY
EDWARDS DAM

Edwards Dam is located in the eastern area of the Appalachian Plateau Province which is characterized by broad, nearly level ridges and deep, steep valleys. Strata east of the dam have been mildly folded to form the Chestnut Ridge Anticline which trends to the northeast. Strata dip away from the axis toward the northwest and southeast at about three to four degrees.

The dam lies at the contact of the Allegheny and Conemaugh groups, both of Pennsylvanian Age. The Allegheny is about 295 feet thick and is composed of massive sandstones and several beds of limestone and fire clay. It also contains many coal beds, four of which are economically minable. The Conemaugh Group is about 650 feet thick and consists of shales of various colors interbedded with coarse sandstones, thin limestones, an several coal beds.

The Upper Freeport Coal has been strip mined in the areas surrounding the dam.



DRAWN BY	ACS	CHECKED BY		DRAWING NUMBER	J43-A12
	12-29-79	APPROVED BY			

CUMMINGS, SAMPLE RUN, ELROY FACE, GRACETON AND EDWARDS DAMS

GEOLOGY MAP

REFERENCE

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA., DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY		DRAWING NUMBER	79-343-A18
	12-31-79	APPROVED BY			

LEGEND

Pc

Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections, Brush Creek Limestone in lower part of section.

Pottsville Group

Light gray to white, coarse grained sandstones and conglomerates with some workable coal; includes Sharp Mountain, Schuylkill and Tumbling Run Formations

Allegheny Group

Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestones Brush Creek, Vanport Limestone in lower part of section; includes Freeport, Kittanning, and Clarion Formations

Clinton Group

Predominantly Rose Hill Formation - Reddish purple to greenish gray, thin to medium bedded, fossiliferous shale with interfingering iron stratum and local gray, fossiliferous limestone above the Rose Hill is base to white quartzitic sandstone (Keefer) is bedded upward with dark gray shale (Rochester)

Om

Marine beds

Gray to olive brown shales, graywackes and sandstones; contains Chemung beds and "Portage" beds including Rockwell Realtor, Harrell, and Trimmers Rock Tully Limestone at base

Pocono Group

Predominantly gray, buff massive coarse bedded conglomeratic and sandstone with some shale; includes in the Appalachian Plateau, Burgoon, Shenango, Cuyahoga, Cussewago, Corry, and Knapp Formations; includes part of "Oswayo" of M.L. Fuller in Potter and Tioga counties

Oriskany Formation

White to brown, fine to coarse grained, partly calcareous, cherty conglomeratic, fossiliferous sandstone; cliff-ledge at the top, dark gray, cherty limestone with some interbedded shales and sandstones below (Shriver)

Tuscarora Formation

White to gray, medium to thick bedded, fine grained, quartzitic sandstone, conglomeratic in part

Marcellus Formation

Black, fissile, carbonaceous shale with thick, brown sandstone (Turkey Ridge) in parts of central Pennsylvania.

Onondaga Formation

Greenish blue, thin bedded shale and dark blue to black, medium bedded limestone with shale predominant in most places, includes Selinsgrove Limestone and Needmore Shale in central Pennsylvania and Buttermilk Falls Limestone and Esopus Shale in easternmost Pennsylvania, in Lehigh Gap area includes Palmerton Sandstone and Bowmanstown Chert

Dmo

Wills Creek Formation

Greenish gray, thin bedded, fissile shale with local limestone and sandstone zones, contains red shale and siltstone in the lower part

Bloomsburg Formation

Red, thin and thick bedded shale and siltstone with local units of sandstone and thin impure limestone, some green shale in places.

McKenzie Formation

Greenish gray, thin bedded shale interbedded with gray, thin bedded, fossiliferous limestone, shale predominant at the base, intraformational breccia in the lower part. Absent in Harrisburg quadrangle and to the east

Keyser Formation

Dark gray, highly fossiliferous, thick bedded, crystalline to nodular limestone, passes into Manlius, Rondout, and Decker Formations in the east

Tonoloway Formation

Gray, highly laminated, thin bedded argillaceous limestone, passes into Bossardville and Pozono Island beds in the east

Catskill Formation

Chiefly red to brownish shales and sandstones, includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east

REFERENCE:

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA. DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

GEOLOGY MAP LEGEND

D'APPOLONIA